Efficiency and Acceptability of Climate Policies: Race Against the Lock-ins

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Abstract

Policymakers have good reasons to favor *capital-based* policies – such as CAFE standards or feebates programs – over a carbon price. A carbon price minimizes the discounted cost of a climate policy, but may result in existing capital being under-utilized or scrapped before its scheduled lifetime, hurt the workers that depend on it, and inflict an immediate income drop. Capital-based policies avoid these obstacles, but can reach a given climate target only if implemented early enough. Delaying mitigation policies may thus create a political-economy lock-in (easier-to-implement policies become unavailable) in addition to the economic lock-in (the target becomes more expensive).

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Introduction

For the past centuries, the global economy has been installing fossil-fueled capital (infrastructure, production processes, energy extraction) that releases greenhouse gases (GHG) in the atmosphere. From a global welfare perspective, this accumulation of polluting capital is sub-optimal because it does not internalize the future economic damages caused by climate change. In other words, fossil-fueled capital has been overvalued for decades, and the world has made suboptimal technological choices based on distorted prices. Today, a large-scale transition towards clean capital accumulation is needed.

To promote this transition, governments have introduced various *capital-based* instruments, such as energy efficiency standards on new capital (e.g. CAFE standards, norms for new buildings and home appliances) or fiscal incentives, such as the "feebates" programs in the automobile sector (Anderson et al., 2011).

Capital-based instruments are less efficient than a carbon price. They regulate emissions embedded in new capital only, instead of regulating all GHG

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gases in the economy as a carbon price would do, and they create the risk of rebound effects if greater energy efficiency leads to more extensive use (Goulder and Parry, 2008).

In Rozenberg et al. (2013b), we argue that the lower efficiency of capital-based instruments comes with an increased social and political acceptability. These instruments reduce the short-term cost of climate mitigation and make a carbon tax more acceptable in the long term. By spreading the costs over time and citizens, they ease the political economy of the transition to clean capital.

A carbon price can induce firms and households to stop using part of their existing polluting capital, with significant consequences on short-term output, employment and consumption. Such an outcome may be politically unacceptable. Instead, capital-based instruments give firms and households the opportunity to make investments consistent with the turnover of their capital stock, that is to keep using existing capital until it depreciates, while investing in cleaner new capital. This may explain why societies are so reluctant to implement carbon taxes, let alone a global agreement on a unique carbon price, and have relied on capital-based instruments such as standards and subsidies instead.

An important downside of capital-based policies is that they cannot curb emissions as fast as the carbon price. If a carbon tax remains impossible to implement in the near future and the transition has to be triggered by capital-based instruments, their slowness makes their implementation (and enforcement) all the more urgent.

A Ramsey model with clean and dirty capital

In Rozenberg et al. (2013b) we compare analytically a carbon price with a set of "capital-based" instruments, and investigate how the inter-temporal distribution of abatement efforts is modified when using these alternative instruments.

We use a simple Ramsey model with two types of capital: "brown" capital and "green" capital. Brown capital emits greenhouse gases that accumulate in the atmosphere. Moreover, brown investment is supposed irreversible, meaning that for instance, a coal plant cannot be turned into a wind turbine, and only disappears through depreciation.

In the model, reducing emissions can be done through two channels. First, through a substitution between brown and green capital, i.e. structural change (as in Acemoglu et al., 2012). This option is slow because it requires capital accumulation in the green sector and depreciation in the brown sector (Vogt-Schilb et al., 2012).

Second, it is possible to instantly reduce emissions through under-utilization of brown capital (or equivalently early-scrapping), i.e. through a contraction of the output volume. This allows unlimited short-term abatement.

Starting from a *laissez-faire* economy that uses mainly brown capital, a social planner decides to maintain the concentration of greenhouse gases in the atmosphere below a certain threshold. This threshold can be interpreted as the *carbon budget* corresponding to an exogenous policy objective such as the UNFCCC "2°C target",[1] or as a tipping point beyond which the environment (and welfare) can be highly damaged.

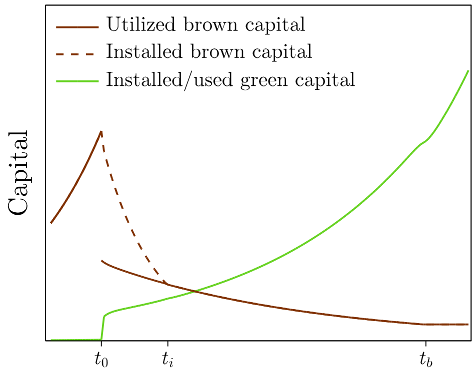

Figure 1: Installed and utilized capital in the intertemporally-optimal transition (with a carbon price). When the carbon price is implemented at t_0, brown capital may be suddenly under-utilized, raising political acceptability issues. At t_i, the overabundant brown capital has naturally depreciated. The balanced growth path is reached at t_b.
Note: we used different scales for green and brown capital.

Capital-based policies lead to the same long-term outcome than the carbon price, without hurting the owners of existing capital

Two strategies are compared to comply with the same climate target. The first one uses a carbon price to regulate all GHG emissions. The second strategy uses alternative instruments that regulate emissions from new capital only, allowing a full utilization of brown capital in the short-run.

We show that the two strategies lead to the same balanced *long-term* growth path (after t_b in Fig. 1). But since investment is irreversible, the economy cannot shift instantaneously to the optimal pathway and the two strategies induce different trajectories during the transition period.

A carbon price minimizes the discounted cost of the transition. When it is implemented, the economy stops investing in brown capital to invest only in green capital.[2] Over the short run, the structure of the economy (the ratio of installed brown to green capital) is not consistent with the new prices. Installed brown capital adjusts to its long-term optimal path through natural depreciation (until t_i in Fig. 1).

During this phase, if the carbon price is lower than the marginal productivity of installed brown capital (as measured in output per emissions), installed brown capital is still fully-used. But if the carbon price is higher, brown capital is under-utilized to reduce immediately carbon emissions (Fig. 1 between t_0 and t_i).[3]

The short-term under-utilization of brown capital has significant short-term impacts on production, which lowers the social and political acceptability of climate policies. It creates two redistribution effects: first, it imposes a downward step on income in exchange for higher consumption for future (possibly richer) generations; second, it affects primarily the owners of brown capital and the workers who depend on it.

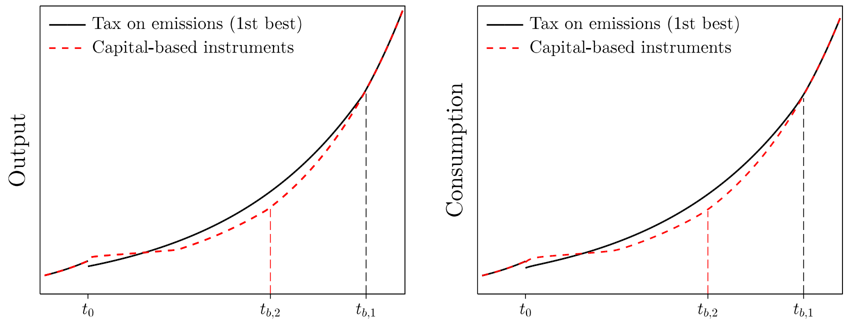

Figure 2: On the left, output in the two cases. In the short-run output is lower in the first-best case because of the adjustment of brown capital utilization. On the right, consumption is higher in the second-best case because of a higher output. t_b is the date when the balanced growth path is reached.

Capital-based policies act as a shadow subsidy in favor of declining brown capital

Instead, it is possible to reduce carbon emissions through investment decisions — i.e. through the redirection of investments towards green capital — without creating an incentive to reduce the utilization rate of brown capital.

A first solution is to differentiate green and brown investment costs, for instance with fiscal incentives, feebates programs or concessional loans for clean capital. Capital costs can also be differentiated using financial markets (Rozenberg et al., 2013a). A second possibility is to regulate new investment through energy efficiency standards (as done for house appliances and personal vehicles). A last possible solution is to complement the carbon price with temporary subsidies to the use of brown capital for the most vulnerable firms or households, so that they see a lower carbon tax and keep using their polluting capital in the short-run.[4]

In our model, these three instruments are equivalent. In practical terms, it would be equivalent to (i) enforce standards for individual vehicle energy efficiency (e.g., CAFE standards), (ii) implement a feebate on cars (depending on their emissions), and (iii) introduce a carbon price and a subsidy to the owners of highly-polluting vehicles. Also, the three instruments eventually lead to the same long-term balanced growth path as a carbon price would, after the transition phase.

When capital-based instruments are implemented, investment in brown capital stops until the structure of the economy has adjusted (as with the carbon price). However, capital-based instruments provide no incentive to under-utilize available brown capital during the transition. The total discounted welfare is lower than in the optimum, but output is higher over the short-run because brown capital is used at full capacity even during the transition (Fig. 2). At one point, the amount of brown capital has adjusted, making it possible to introduce a carbon price without capital under-utilization, hence without the acceptability issues discussed earlier.

Capital-based policies therefore only differ temporarily from the first-best pathway, in a way that smooths the transition costs: they decrease efforts in

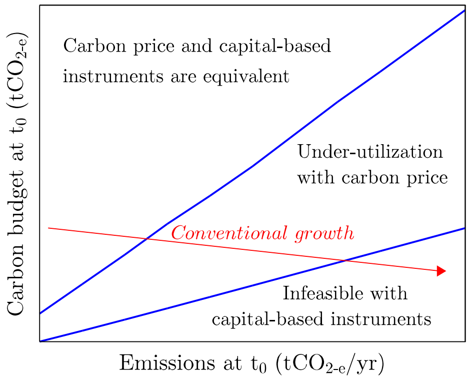

Figure 3: Depending on emissions (i.e. brown capital) when the policy is implemented at t_0 and on the carbon budget at t_0 (the climate target), the carbon tax and capital-based instruments can lead to different or similar outcomes. While the economy is on the laissez-faire growth path (red arrow), brown capital accumulates and the carbon budget is reduced (for a given climate objective).

the short-run, increase them in the medium-run, and leave them unchanged in the long-run.

Race against the lock-in

The carbon price does not always lead to under-utilize brown capital, depending on the stringency of the climate target and the level of emissions embedded in installed capital (Fig. 3). As long as climate policies are absent (or very lax), the global economy accumulates brown capital, making GHG emissions grow and reducing the carbon budget for a given climate target (the “conventional growth path” in Fig. 3).

If the amount of preexisting brown capital is low (left hand side, Fig. 3), a carbon tax does not lead to under-utilization of brown capital and reaching the climate target is possible and optimal without a downward step in income. In this case, the carbon price consistent with the climate target leads to the exact same growth path as capital-based policies. This is a situation of “flexibility” in which a country can chose a brown or a green development path at low cost, using either a carbon price or capital-based instruments.

At one point, brown capital reaches the level when a carbon price induces capital under-utilization and its negative political economy consequences. From there, a carbon price becomes more difficult to implement. But the alternative option of using capital-based instruments is available, leading to higher inter-temporal costs but no immediate drop in income. There is a window of opportunity, during which alternative capital-based instruments may induce a smooth and acceptable transition to a low-carbon economy.

If this occasion is missed (right hand side, Fig. 3), it becomes impossible to reach the climate target without under-utilization of brown capital and capital-based options are not available any more (if the climate objective is not revised). According to Davis et al. (2010), the level of existing polluting infrastructure in 2010 is still low enough to achieve the 2°C target without under-utilizing brown capital, suggesting that the global economy is not in this last region yet.[5] When we get in this area, not only the economic cost of reaching the climate target is higher, but the political economy also creates a carbon lock-in: the only option to reach the climate target has a significant short-term cost, making it more difficult to implement successfully a climate policy consistent with the target.

Conclusion

There is a trade-off between the inter-temporal optimality of a climate policy and the acceptability of its short-term impacts. In pure economics terms, the carbon tax is the best tool to maximize discounted welfare. But public policy is especially difficult in contexts where costs are immediate, concentrated and visible; and benefits are diffuse over time and over citizens (Olson, 1971). Capital-based instruments can help spread the cost of climate mitigation over time and across citizens.

Standard economic theory establishes that this equity issue is best tackled using targeted lump-sum cash transfers to compensate the losers. In practice, however, it may not be feasible to monitor and compensate each individual loser of climate mitigation policies (e.g., Kanbur, 2010). The transfers themselves may appear unacceptable to other actors, especially if they go to a relatively wealthy population. Instead, capital-based instruments have the potential to tackle both the efficiency (they reduce emissions) and the equity (they compensate losers) functions of a climate mitigation policy.

Sector-specific capital-based instruments create risks from capture and rent-seeking (Laffont and Tirole, 1991). Applying them is therefore challenging: it requires strong institution settings and controls (Rodrik, 2008). But if a carbon price — possibly complemented with lump-sum transfers for equity reasons — remains impossible to implement and if policy-makers take the climate issue seriously, the question is not whether to implement capital-based instruments or not, but when and how to do it (Hallegatte et al., 2013).

Notes

[1]Climate research shows that global temperature change may be approximated by cumulative emissions (Allen et al., 2009; Matthews et al., 2009).

[2]During this period, the rental price of brown capital decreases below that of green capital.

[3]During this period, the rental price of brown capital decreases to zero (polluting capital is overabundant).

[4]The free allowance distributed to energy-intensive industries during the implementation of the EU-ETS (also known as *grandfathering*) is similar to this last option.

[5]Davis et al. (2010) do not discuss whether an optimal climate policy (i.e. a policy that minimizes the discounted cost) would lead to under-utilization, that is whether we are in the top or the middle triangle in Fig. 3.

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